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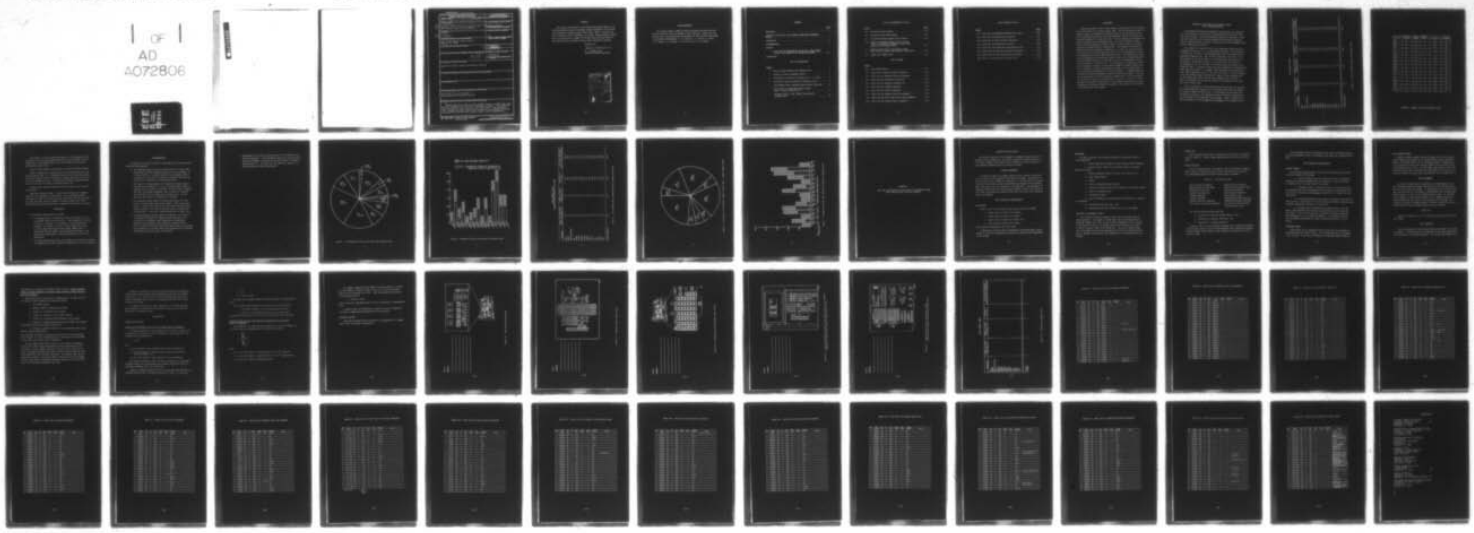

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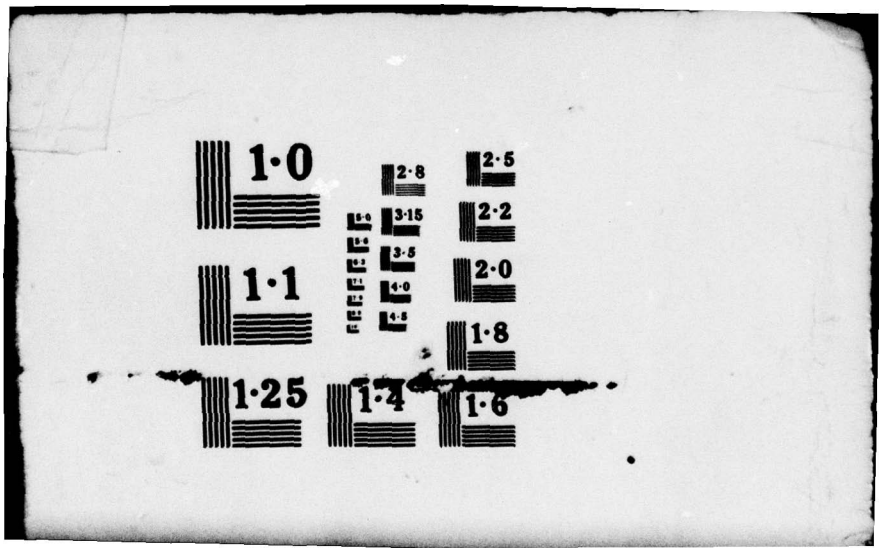
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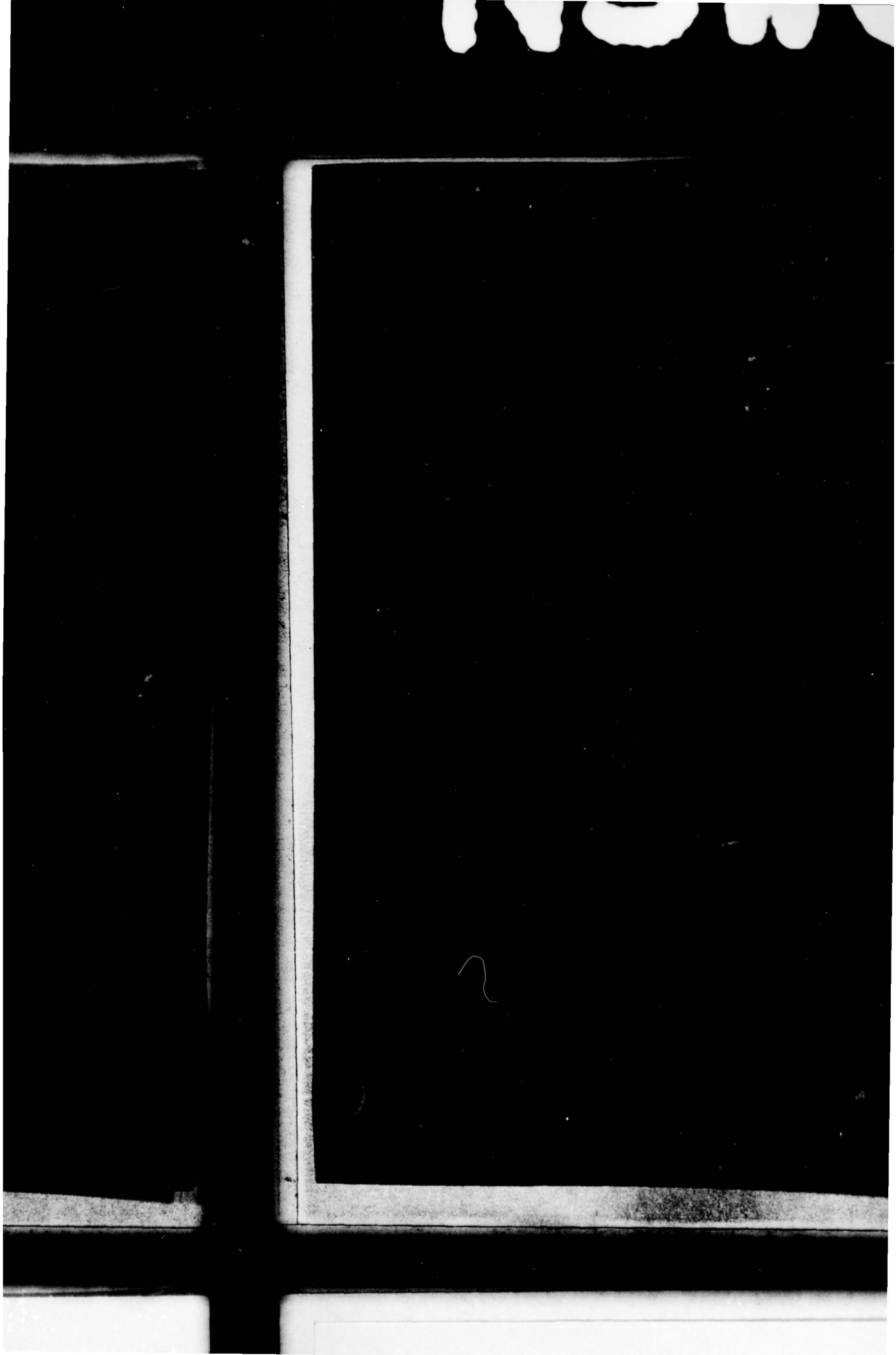

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Random sampling was used to select hardware faults to evaluate the fault detection capabilities of Mk 98 Mod 0 maintenance software. This report contains the test plan and an analysis of the test results. The evaluation effort produced an overall gross figure-of-merit for the software, and identified several areas for which in-depth studies would be appropriate.

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FOREWORD

This report was prepared in the Systems Engineering Branch of the FBM Geoballistics Division, Strategic Systems Department, with funding of the Strategic Systems Project Office (SSPO) (SP23). The work was done in support of MK 98 (TRIDENT) Fire Control System Software Development, and constitutes a summary of the NSWC fault analysis effort on the General Electric Ordnance Systems (GEOS) maintenance software.

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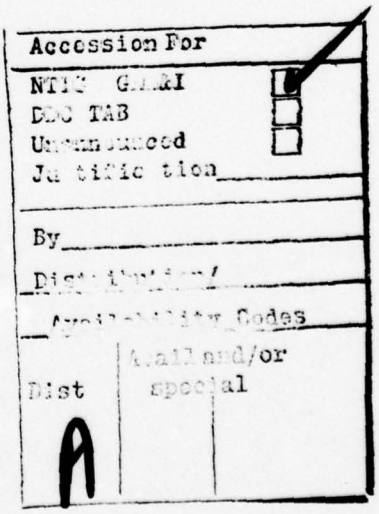

ACKNOWLEDGEMENTS

The author wishes to thank the many individuals from NSWC and EG&G who participated in the development of this test plan. Among those who played a part, the significant contributions of the following individuals are gratefully acknowledged: P. S. Altman, J. C. Carlock, D. Carter, G. W. Gemmill, W. S. Hutton, T. W. Smith, and Dr. M. A. Thomas.

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BACKGROUND

GEOS has developed a set of Fault Detection and Isolation (FDI) programs for the Mk 98 Mod 0 Fire Control System (FCS). The FDI software has been designed to detect the presence of hardware faults in the FCS and to produce fault signatures which can be used with appropriate fault dictionaries and isolation procedures to locate the fault. The FDI software was scheduled for formal acceptance by the Government early in CY 1978 following a formal Software Quality Assurance Procedure (SQAP) (hereafter called the GE-SQAP) conducted at GEOS/Pittsfield, Massachusetts. The GE-SQAP (as described in NAVSEA OD 50839) was designed to demonstrate (1) that the software operates as specified in the design documents, and (2) that the software will interface appropriately with the NSWC-generated Monitor. The GE-SQAP plan called for 250 preselected and checked-out hardware faults and 25 extemporaneously selected hardware faults to be inserted in the FCS to demonstrate the run-to-fail operation of each FDI test. The GE-SQAP was not designed to demonstrate isolation of faults to any specified number of hardware modules, nor was it designed to produce a quantitative estimate of the effectiveness of the fault detection capabilities of the FDI software. A separate SQAP was performed at Dahlgren Laboratory (hereafter called the DL-SQAP) to estimate the effectiveness of the fault detection capabilities of the FDI software. The DL-SQAP was conducted at NSWC/Dahlgren, Virginia, concurrently with the GE-SQAP at Pittsfield, Massachusetts. This document delineates the goals, assumptions, limitations, methods, procedures, and results for the DL-SQAP of the Mk 98 Mod 0 FDI software.

ANALYSIS OF MK 98 MOD 0 FIRE CONTROL SYSTEM FAULT INSERTION RESULTS

Four-hundred and forty-nine randomly selected faults were inserted into 15 subsystems of the Mk 98 Mod 0 Engineering Tactical System (ETS) Fire Control System. Using the procedures specified in Appendix A, each fault was tested with the test associated with the hardware subsystem, and the results recorded as either a detected fault or an undetected fault. Figure 1 summarizes the results.

The estimate ($\hat{p}$) shown for each of the subsystems tested should be interpreted as follows: $\hat{p}$ is the experimental estimate of the proportion of faults that can occur in the subsystem which will be detected by the associated subsystem test. The 90% Lower Confidence Bound (LCB) is the lower bound on $\hat{p}$ for which there is a 90% probability that faults will be detected. Referring to Figure 1, it can be stated that there is a 90% probability that 78% (or more) of all faults will be detected by the subsystem tests. It should be noted that some subsystems are substantially lower than this however. For example, the System Mode and Configuration Logic (SMCL) subsystem has a $\hat{p}$ of .433 and a 90% LCB of .308 which appears to be unacceptable unless the majority of faults in that subsystem will be detected by tests other than the SMCL subsystem test or faults in SMCL are detectable by the operator viewing the indications on the Operator Control Panel (OCP).

Further examination of the undetected faults which were not detected by the subsystem tests showed that the subsystem tests were not designed to include a number of those faults. This analysis was performed using information contained in the appropriate design disclosure documentation and an analysis of the subsystem logic diagrams. Figure 2 summarizes the data with respect to faults <u>tested</u> and <u>not tested</u> by the subsystem tests.

DATA SUMMARY SHEET

Subsystem	Number of Faults Inserted (T)	Number of Faults Detected (D)	Estimate of $\hat{p} = D/T$	90% Lower Confidence Bound on True Proportion
BPSS	30	29	.967	.876
MDFSS	30	21	.700	.568
MUX Controller	30	28	.933	.832
CIU	30	23	.767	.639
KBDSS	30	26	.867	.751
PTRSS	30	28	.933	.832
MTFSS	30	28	.933	.832
TCDSS	30	25	.833	.713
DRISS	30	26	.867	.751
HADL	30	24	.800	.675
DCSS	30	30	1.000	.926
SCL	29	17	.586	.450
SMCL	30	13	.433	.308
CMSS	30	19	.633	.500
OCP	30	24	.800	.675
System Summary	449	361	0.804	0.780

Figure 1. Fault Insertion Results Data Summary Sheet

Subsystem	Total Faults Selected	Number Tested	Number Not Tested	$\hat{p}$ (Not Tested)	90% LCB (Not Tested)
BPSS	30	29	1	.033	.124
MDFSS	30	22	8	.267	.397
MUXC	30	28	2	.067	.168
CIU	30	26	4	.133	.249
KBDSS	30	30	0	0	.074
PTRSS	30	29	1	.033	.124
MTFSS	30	28	2	.067	.168
TCDSS	30	25	5	.167	.287
DRISS	30	30	0	0	.074
HADL	30	25	5	.167	.287
DCSS	30	30	0	0	.074
SCL	29	18	11	.379	.500
SMCL	30	15	15	.500	.630
CMSS	30	24	6	.200	.325
OCP	30	24	6	.200	.325
TOTALS	449	383	66	.147	.168

Figure 2. Summary of Faults Tested/Not Tesed

From Figure 2, it can be noted that there is a 90% probability that as many as 17% of the total system faults may not be tested by the subsystem tests. This number rises to 63% for the SMCL and 50% for the System Control Logic (SCL).

Figures 3 and 4 present the same data in slightly different format.

Figure 5 summarizes the results after the untested faults have been removed from the data. It is estimated that the tests will detect about 95% of the remaining faults, although the estimate may fall as low as 93% at the 90% probability level. The Computer Maintenance Subsystem (CMSS) has a $\hat{p}$ of 79% and a 90% lower confidence bound of 65%.

Figures 6 and 7 show the same data from the point of view of undetected faults.

Additional analyses showed no significant differences in response among the four categories of fault types. All the undetected faults occurred in a group of 11 module key codes (BBB, BDL, GBB, HVA, KDN, KDR, LDC, LDN, LDQ, PDL, and BDC); however no specific module type can be identified as being more susceptible to undetected faults than the others.

CONCLUSIONS

The following conclusions were reached:

1. The subsystem tests, by themselves, fail to test about 17% of the possible faults which can occur. (This number may be lowered if there are overlaps in the boundaries of the hardware and software. For example, if some of the SCL faults are picked up by the Temperature Monitor Power Supply (TMPS) tests, or vice-versa, then the numbers and conclusions may change). The SMCL and SCL tests appear to have particularly high "untested" proportions.

2. For those hardware faults that are included in the "tested" category, the subsystem tests have a detection capability of 93% on the average.

RECOMMENDATIONS

The results of the fault insertion study suggest the need for several additional investigations.

1. The undetected faults should be analyzed further to verify that they actually produce an abnormal condition in the equipment (if a "stuck-at-one" is a normal condition in the hardware, then a "stuck-at-one" fault will not produce an abnormal condition and should not be classified as an undetected fault).

2. The amount of overlap between the software and hardware subsystems should be determined. If, due to software partitioning, a hardware fault is tested by a software test which has a different name than the hardware subsystem, then it should be confirmed that the fault will be picked up by the other test. In such cases the fault would be classified as "detected."

3. The undetected faults should be further partitioned into categories of serious faults and trivial faults. (For this investigation, a serious fault would be one that would adversely affect system readiness if it were not detected prior to entering the Tactical mode). Other fault classifications may be useful also.

4. The FCS maintenance protocol should be examined. Since there is a substantial proportion of possible faults that will not be detected by the subsystem tests themselves, do maintenance schedules and procedures provide adequate assurance the FCS will not contain undetected faults when Tactical mode is initiated? The probability of a serious fault going undetected until Tactical mode should be quite low (say, less than 5%).

5. Enhancements to increase the effectiveness of the subsystem tests should be developed. Such enhancements should be directed toward reducing the number of untested faults and reducing the number of undetected faults. (The SMCL, SCL, and CMSS tests appear to be prime candidates for such enhancements).

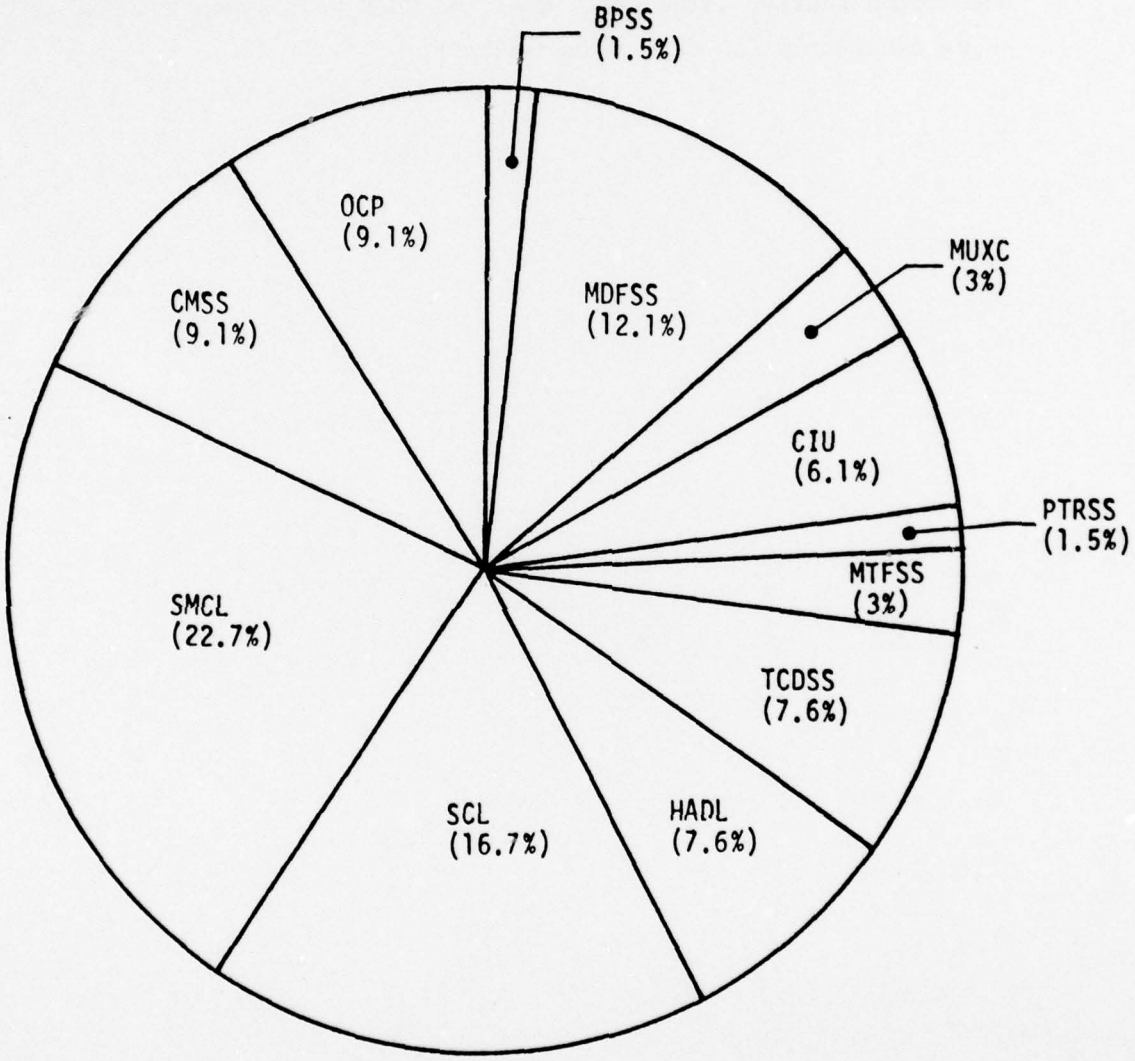

Figure 3. Distribution of Faults not Tested by Subsystem Tests

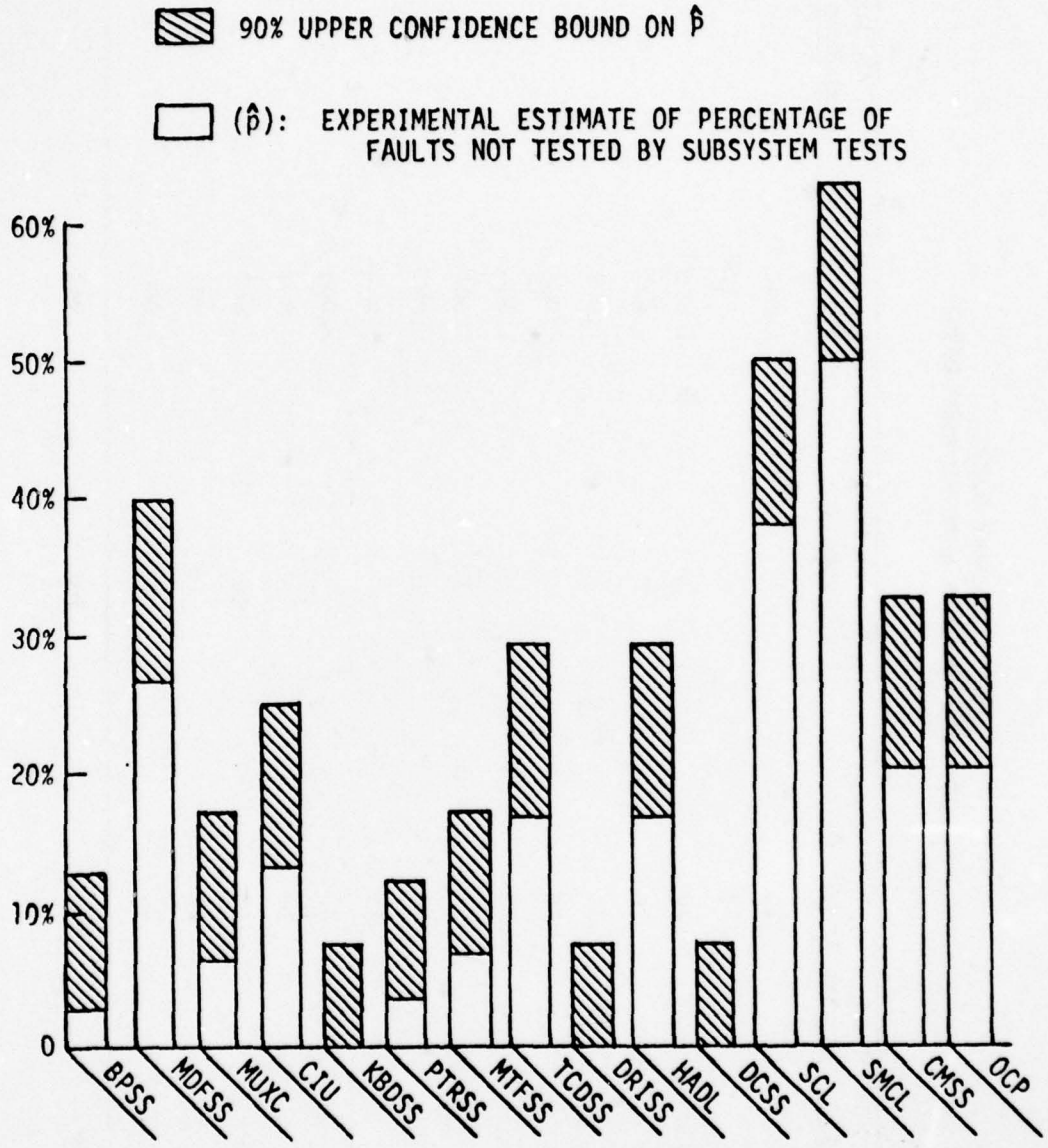

Figure 4. Estimate of Faults not Tested by Subsystem Tests

DATA SUMMARY SHEET
(UNTESTED FAULTS REMOVED FROM DATA)

Subsystem	Number of Legitimate Faults Inserted (T)	Number of Faults Detected (D)	Estimate of $\hat{p} = D/T$	90% Lower Confidence Bound on True Proportion
BPSS	29	29	1.000	.924
MDFSS	22	21	.957	.834
MUX Controller	28	28	1.000	.921
CIU	26	23	.885	.761
KBDSS	30	26	.867	.751
PTRSS	29	28	.966	.872
MTFSS	28	28	1.000	.921
TCDSS	25	25	1.000	.912
DRISS	30	26	.867	.751
HADL	25	24	.960	.853
DCSS	30	30	1.000	.926
SCL	18	17	.944	.801
SMCL	15	13	.867	.683
CMSS	24	19	.792	.648
OCP	24	24	1.000	.901
System Summary	383	361	.943	.927

Figure 5. Data Summary Sheet (Untested Faults Removed from Data)

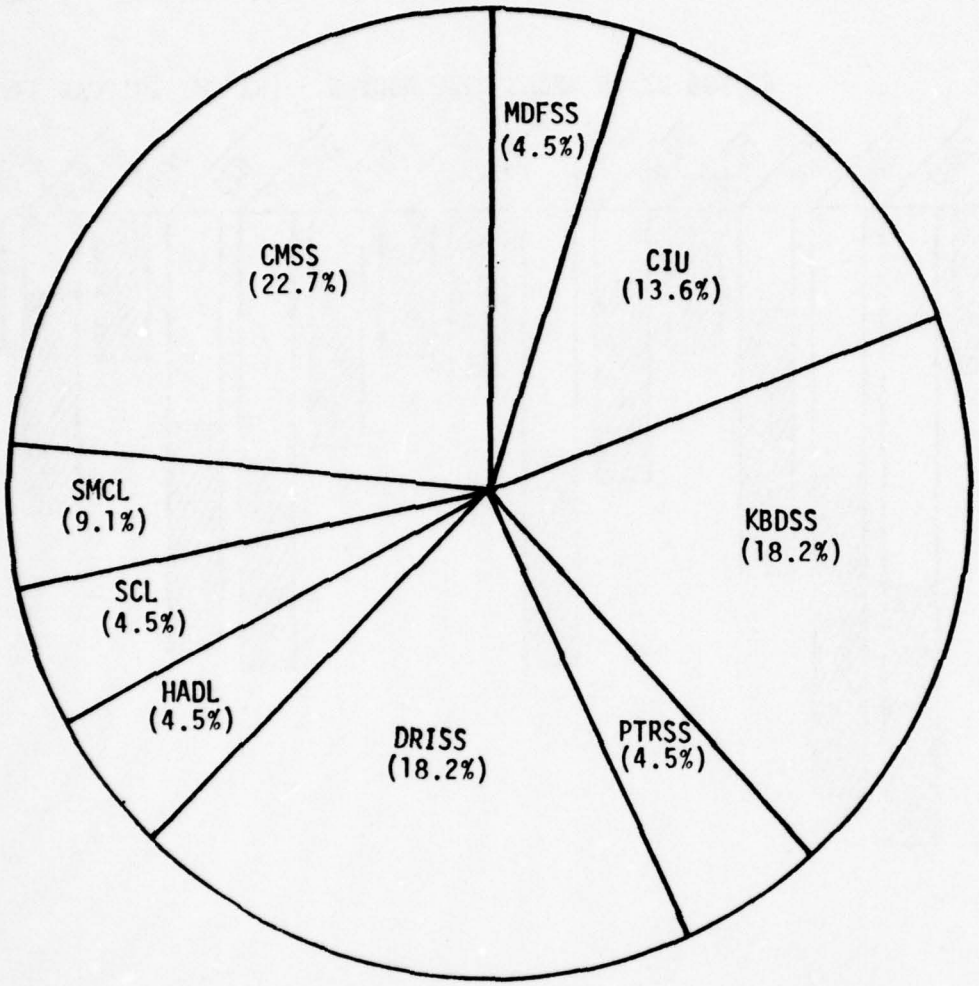

Figure 6. Distribution of Undetected "VALID" Faults (Note: Unequal Sample Sizes)

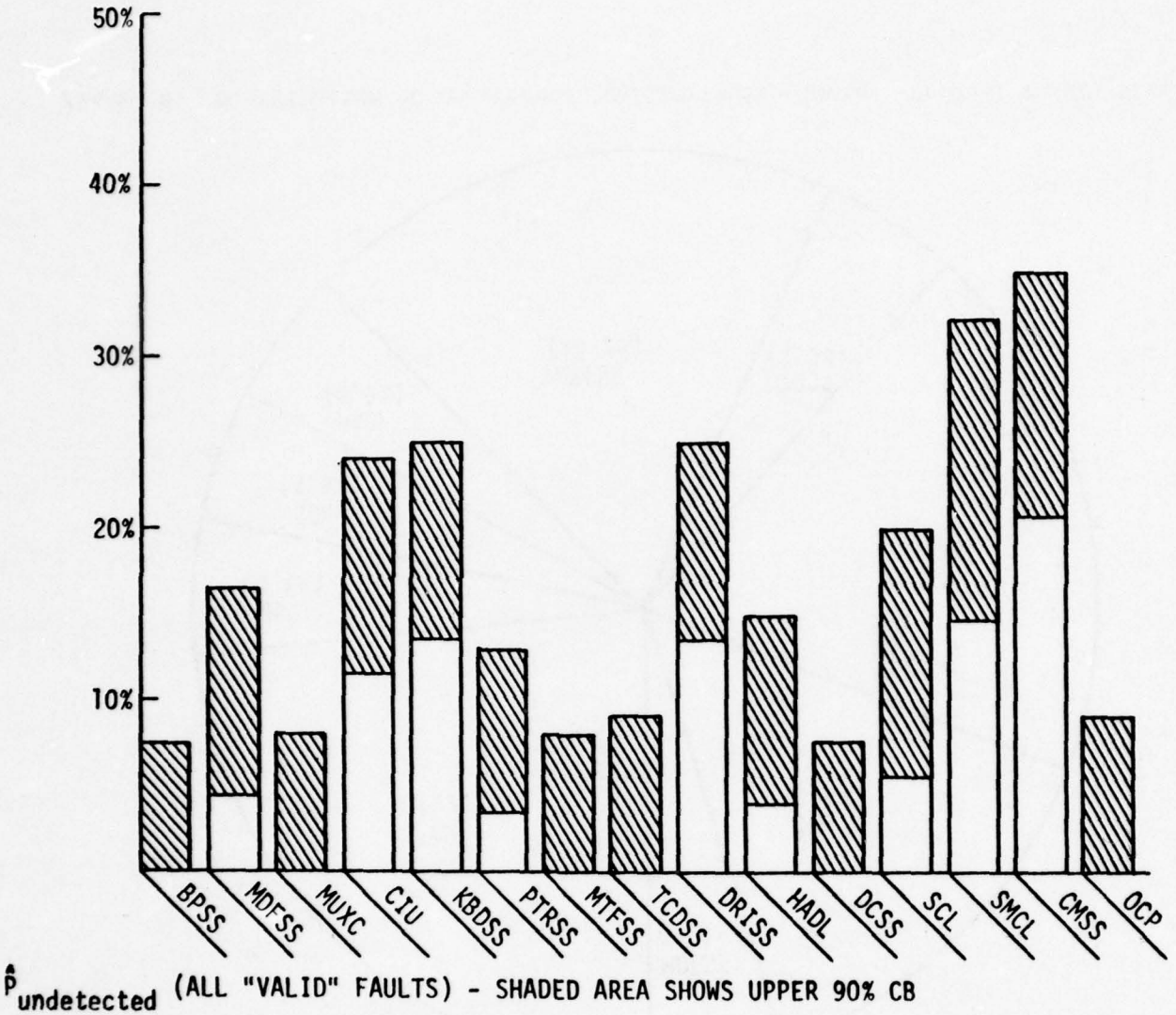

Figure 7. Estimate of Faults that "Should" be Tested by Subsystem Test

APPENDIX A

TEST PLAN FOR EVALUATION OF MK 98 MOD 0 FIRE CONTROL SYSTEM FAULT DETECTION AND ISOLATION SOFTWARE

OBJECTIVE OF THE DL-SQAP

The primary objective of the DL-SQAP is to generate data with which to estimate the true proportion, and compute a lower 90% confidence bound, of all "legal" hardware faults which can be detected by the FDI software for each hardware subsystem, and for the FCS as a whole.

GENERAL METHODOLOGY

A statistical sample of hardware faults will be inserted into the FCS one at a time, and the appropriate FDI test(s) performed. The results of the FDI test will be recorded as a detection or a non-detection of the fault (if the FDI test fails to detect and indicate the presence of the hardware fault, the results will be recorded as a non-detection). The population of subsystem faults from which the statistical sample is drawn will consist of all "legal," non-duplicate hardware faults which can occur in the subsystem under investigation.

FAULT SELECTION CONSIDERATIONS

FAULT-TYPES

There will be four permissible fault-types used in the DL-SQAP:

1. Output stuck at (logic) zero (O/SA0),
2. Output stuck at (logic) one (O/SA1),
3. Input stuck at (logic) one (I/SA1), and
4. Input stuck at (logic) zero (I/SA0).

Fault-types are indicated on the fault lists.

Intermittent faults and faults representing (non-catastrophic) degradation of circuits or components are explicitly excluded from consideration in the DL-SQAP.

EXCLUSIONS

For this evaluation, the following categories are excluded from the fault population:

1. Faults explicity excluded by the FDI software design documents,
2. Analog circuits (faults in the digital portions of analog modules are legal),
3. Passive component modules (pull-ups, test points, etc.),
4. Power supply modules,
5. Cables,
6. Faults in Dahlgren-unique circuits,
7. "Stuck-at" conditions which are normal for a particular circuit,
8. Faults in redundant logic,
9. Intermittent faults,
10. Faults representing (non-catastrophic) degradation of circuits or components,
11. Simultaneous multiple faults, and
12. Faults which have been selected for use in the GE-SQAP.

DUPLICATE (OR REDUNDANT) FAULTS

To the extent practical, duplicate faults will be excluded from the fault population. For example, although there are seven Digital Read-in Subsystem (DRISS) units, only one set of DRISS components will be included in the fault list since it is assumed that the FDI software will be able to detect a specific fault in any DRISS unit. The list of sample faults will be reviewed to ensure that duplicate faults are not included inadvertently. Hardware faults used for the GE-SQAP will not be duplicated in the DL-SQAP.

SAMPLE SIZE

Thirty hardware faults shall be selected for each group of equipment listed in Table A-1. Simple random sampling shall be used to select all faults.

SAMPLE SELECTION

For each subsystem except the Magnetic Disk File Subsystem, hardware faults shall be selected from module layouts derived from the Automatic Logic Implementation/Machine Aided Drafting System (ALI/MADS).

Table A-1. FDI Software Tests

Basic Processor Subsystem	Digital Read-In Subsystem
Magnetic Disk File Subsystem	Hardware Alarm Detection Logic
Multiplexer Controller	Time of Day Subsystem
Computer Interface Unit	Data Converter Subsystem
Keyboard Subsystem	System Control Logic
Printer Subsystem	System Mode Configuration Logic
Magnetic Tape File Subsystem	Computer Maintenance Subsystem
Test Control and Display Subsystem	Fire Control Clock Oscillator
	Operator Control Panel

The fault selection sequence shall be:

1. Selection of a specific hardware module (type 3),
2. Selection of a specific fault-type, and
3. Selection of a specific module pin.

Items (1) and (2) will be selected randomly from a uniform distribution of fault-types; item (3) will be selected manually from appropriate drawings and the Automatic Fault Insertion (AFI) listings to ensure that an active circuit is used.

For the Magnetic Disk File Subsystem, faults will be randomly selected from the comprehensive fault list produced by the NSWC Logic Simulation Program.

FAULT INSERTION CONSIDERATIONS

PROCESS SEQUENCE

The following sequence shall be followed where possible for the fault insertion process of the DL-SQAP:

1. The FDI software under test shall be run with an unfaulted system and any abnormal conditon shall be corrected. This process shall be repeated until a test-pass result is obtained.

2. The module (type 3) in which the fault is to be inserted will be installed along with the appropriate fault insertion media and the FDI test run for a test-pass under no-fault conditions (i.e., without the hardware fault).

3. The selected hardware fault shall be inserted and the FDI test shall be rerun. The results of the FDI test with the faulted system shall be recorded as specified in Tables A-2 through A-18.

4. The FCS shall be restored to an unfaulted state, the next module installed along with its fault insertion media, and the same FDI test rerun. If an abnormal condition is present, it shall be corrected and procedures (2) and (3) shall be repeated. (A run-to-pass condition will be obtained both before the fault is inserted and after it is removed.)

UNDETECTED FAULTS

Faults which are not detected by the FDI test will be reanalyzed to verify that they are "legal" faults. If an undetected fault is determined to be "illegal," it will not be included in the DL-SQAP primary analysis.

FAULT INSERTION MEDIA

Normally, special extender boards and jumper wires will be used to insert hardware logic faults at the selected module and pin locations. However, in instances where the use of extender boards or jumper wires is not appropriate, other fault insertion media (such as specially pre-faulted modules) may be used. In those cases, some details of the fault insertion sequence may be modified; the requirement for a test-pass condition both before and after fault insertion will not be altered however.

TEST ENVIRONMENT

The entire DL-SQAP shall be performed on the NSWC/Dahlgren Mk 98 Mod 0 Engineering Tactical System (ETS) using the 420 disk pack version that was prepared for the GE-SQAP. If GEOS modifies any of the FDI software after the start of the DL-SQAP, a determination shall be made about what portion(s), if any, of the DL-SQAP should be rerun. It should be noted, however, that the entire DL-SQAP is to be completed first with the FDI programs as they exist at the beginning of the GE-SQAP; any necessary retesting of changed portions of the FDI software will be performed after the entire DL-SQAP sequence has been completed.

FAULT LIST

Tables A-2 through A-18 list the hardware faults that were used for the DL-SQAP.

DATA COLLECTION

The test sequence for fault insertion will be performed in a systematic manner. A run-to-pass will be conducted for any given subsystem to be faulted prior to any fault insertion. Test sequence procedures to be

followed will be contained in NAVSEA OD 50839, Volume 2, General Electric Ordnance Systems TRIDENT-I Fire Control System Software Quality Assurance Plan and Procedures.

Data records will be compiled in a SQAP Log Book. The SQAP Log Book will consist of the following log sheets and figures:

1. Log comment sheets,
2. Magnetic Tape File Subsystem log sheets,
3. Figure A-1, Time-of-Day Panel Display,
4. Figure A-2, Operator's Control Panel Display,
5. Figure A-3, Integrated Testing Operator Panel Display,
6. Figure A-4, Computer Maintenance Display (440A1) and Computer Maintenance Control Panel Display (440A2), and
7. Figure A-5, Magnetic Disk File 2(1) Maintenance Panel, Upper Section Display (446A2/447A2).

Also, the SQAP Log Book will contain the fault lists for the subsystems to be faulted. An entry of undetected (U) or detected (D) will be added to the fault lists as each test is performed.

The log comment sheets will be used to record general information such as date, time, system configuration, and the subsystem which is to be faulted. The log comment sheets will also be used to record any unusual or abnormal conditions and items of special interest that may arise while performing fault insertion procedures. The Magnetic Tape File log sheets will be used to record the number of times the tape file attempts to read a tape during a maintenance bootstrap operation if the test data fails to be read from the magnetic disk file.

Figures A-1 through A-5 will be utilized when pertinent information requires their use by marking out and annotating specific light indications with an "x". Several or none of the pictorials may be used for a specific subsystem test; however, the subsystem fault list will be completed for all tests.

For every given test case (fault insertion), all related printouts and pictorials, as required, will be grouped together as one entry and maintained in the SQAP Log Book.

DATA ANALYSES

PRIMARY DATA ANALYSIS

Estimate of FDI Software Fault Detection Capabilities by Subsystem

The data associated with each subsystem will be used to estimate the fault detection capability of the FDI software for that subsystem. The estimate will be calculated as:

$$\hat{p} = \frac{D}{T}$$

where

$\hat{p}$ is the estimate of the subsystem fault detection capability,

D is the total number of inserted faults which were detected by the FDI software; and

T is the total number of faults inserted into the subsystem.

The lower 90% confidence limit for the true proportion of detectable subsystem faults will be determined from standard statistical tables of one-sided confidence limits for proportions.

Assume, for example, that a total of 30 faults have been inserted in a subsystem and that the FDI software detected 29 of them. In this case,

$T = 30$

$D = 29$

$\hat{p} = 29/30 \cong 0.9667$

The lower 90% confidence bound for the above example is approximately 0.876.

The following interpretation is to be given to the above figures:

1. The sample estimate of the true proportion is 96.67%.

2. There is a 90% probability that the FDI software under investigation will detect 87.6%, or more, of the faults in the subsystem.

Estimate of FDI Software Fault Detection Capabilities for the Total Group of Subsystems

The estimate of the fault detection capability of the FDI software for the entire group of subsystems will be calculated as follows:

$$\hat{p} = \frac{\sum_{i=1}^{n} D_i}{\sum_{i=1}^{n} T_i}$$

where

D_i is the total number of detected faults in the i^{th} subsystem;

T_i is the total number of inserted faults in the i^{th} subsystem; and

n is the total number of subsystems tested.

For example, assume the total number of inserted faults is 540 and the total number of detected faults is 520 (i.e., 20 of the inserted faults were not detected by the FDI). Then the estimated system fault detection proportion is

$$\hat{p} = 520/540 \simeq 0.963$$

and the lower 90% confidence bound on the true proportion is approximately 0.953.

A summary sheet, as illustrated in Figure A-6, will be prepared as one means of summarizing and presenting the test results.

SECONDARY ANALYSES

Additional analyses will be performed on an ad hoc basis to suggest likely areas for further investigation.

FAULT:

REMARKS:

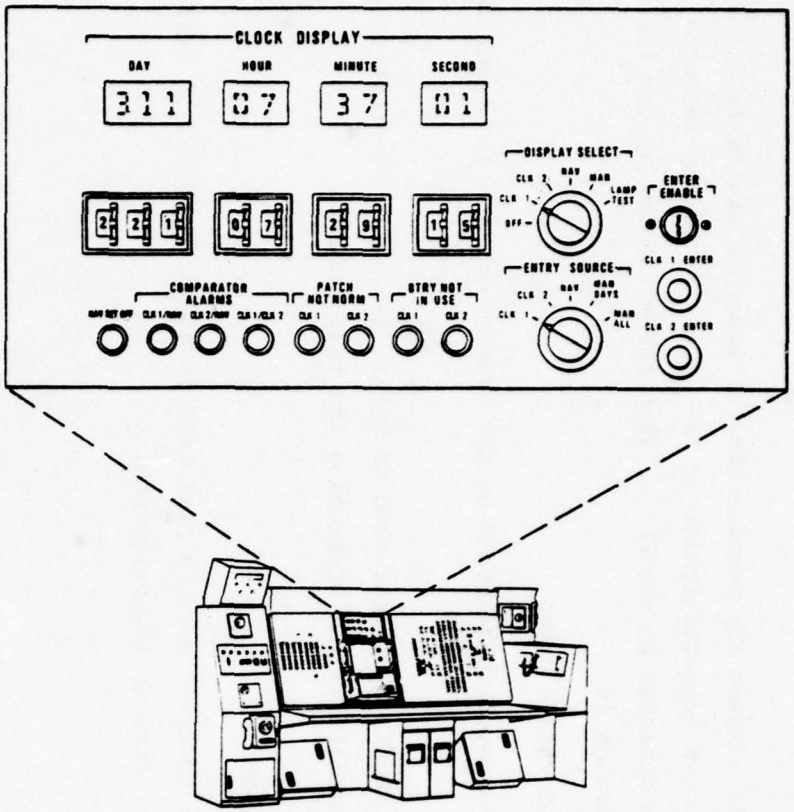

Figure A-1. Time-of-Day Panel Display

FAULT:

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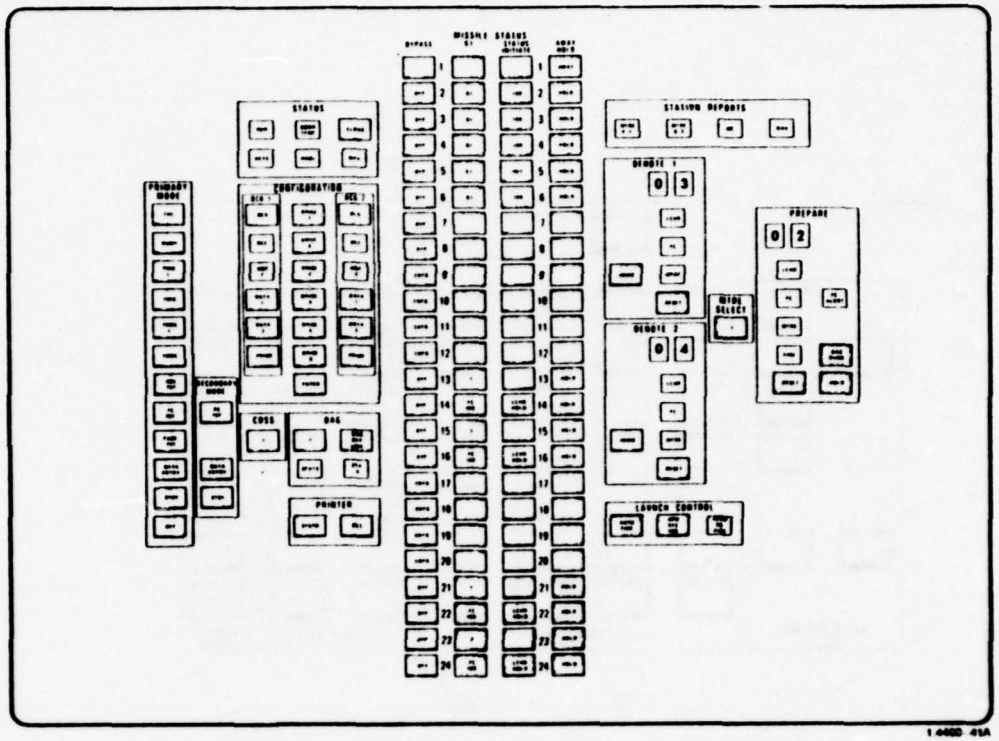

Figure A-2. Operator Control Panel Display

FAULT:

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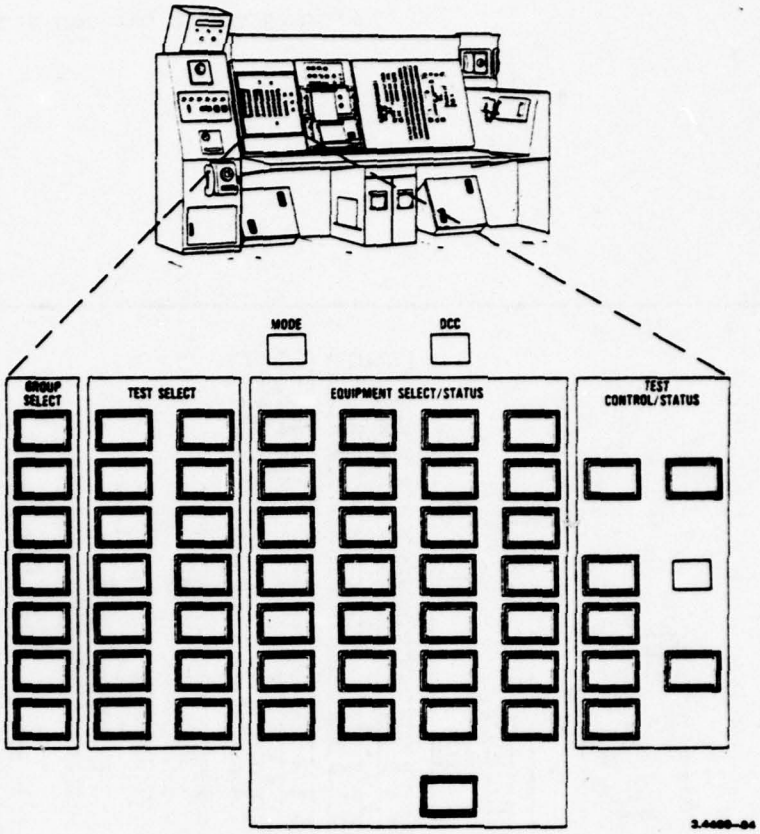

Figure A-3. Integrated Testing Operator Panel Display

FAULT:

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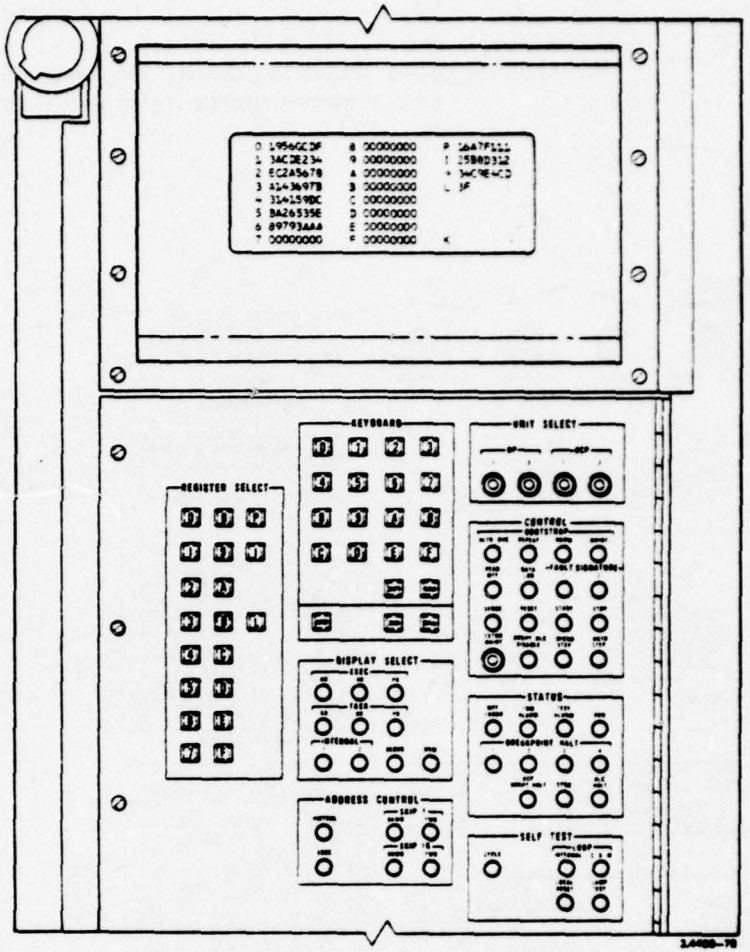

Figure A-4. Computer Maintenance Display (Door Location 440A1) and Computer Maintenance Control Panel Display (Door Location 440A2)

FAULT:

REMARKS:

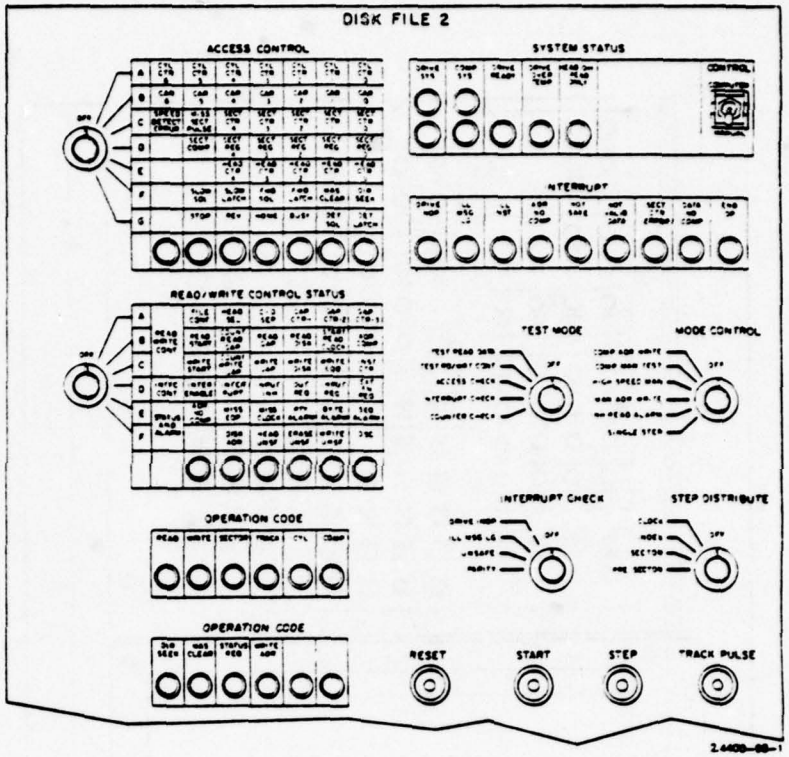

Figure A-5. Magnetic Disk File 2(1) Maintenance Panel, Upper Section Display (Door Location 446A2/447A2)

DATA SUMMARY SHEET

Subsystem	Number of Faults Inserted (T)	Number of Faults Detected (D)	Estimate of $\hat{p} = D/T$	90% Lower Confidence Bound on True Proportion
BPSS				
MDFSS				
MUX Controller				
CIU				
KBDSS				
PTRSS				
MTFSS				
TCDSS				
DRISS				
HADL				
TODSS				
DCSS				
SCL				
SMCL				
CMSS				
FCCO				
OCP				
System Summary				

Figure A-6. Sample Data Summary Sheet

Table A-2. Fault List for Basic Processor Subsystem

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	442C13E042	KHL	30	I/SA0	3431512-1	D	-	
2	442C13F096	KHL	36	O/SA0	3431529-1	D	-	
3	442C06C060	KHL	18	I/SA0	3431456-2	D	-	
4	442C06B129	KHL	21	O/SA1	3431458-6	D	-	
5	442C06C156	KHL	22	O/SA0	3431460-3	D	-	
6	442C06D162	KHL	11	I/SA1	3431460-7	D	-	
7	442C06G144	KHL	8	O/SA1	3431494-2	D	-	
8	442C06E159	LMP	35	O/SA0	3431497-2	D	-	
9	442C06A093	MHL	27	I/SA1	3431470-1	D	-	
10	442C06F144	RBG	21	O/SA1	3431497-2	D	-	
11	442D14F075	CBF	29	O/SA0	3431671-1	D	-	Read from tape
12	442D14A087	FDA	13	O/SA1	3431684-1	D	-	
13	442D14F111	JDB	5	I/SA0	3431672-3	D	-	
14	442D14F030	KDN	23	O/SA0	3431671-1	D	-	Detected in MXC/Read from tape
15	443B14A042	LMH	5	I/SA1	3431705-2	U	-	
16	442C01D090	GBB	38	O/SA0	3431405-3	D	-	
17	442C01D048	JDB	33	O/SA0	3431423-2	D	-	
18	442C01E150	LMH	17	O/SA0	3431421-1	D	-	
19	442C01B135	RBF	4	O/SA1	3431432-1	D	-	
20	442D02A063	CBF	29	O/SA1	3431577-1	D	-	
21	442D02C081	CBF	33	I/SA1	3431563-2	D	-	
22	442D02D069	KHL	35	I/SA0	3431570-3	D	-	
23	442D02E039	LDN	21	O/SA0	3431570-6	D	-	
24	442D07F132	KHL	21	O/SA1	3431615-2	D	-	
25	442D07A030	LHH	35	O/SA0	3431628-2	D	-	
26	442D07D036	RBG	23	O/SA1	3431610-4	D	-	
27	442D07G060	RDH	11	I/SA0	3431620-2	D	-	
28	442D07G084	RDH	9	O/SA0	3431618-2	D	-	
29	443B10D084	BYT	6	I/SA0	3431755-12	D	-	Read from tape
30	443B10B033	CBF	3	I/SA1	3431759-1	D	-	Read from tape

Table A-3. Fault List for Magnetic Disk File Subsystem

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	FCD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	047B10E045	ADH	6	OPEN	2648228-39/1	U	-	
2	047B10E126	ADH	17	OPEN	2648228-23/3	U	-	
3	047B10C054	BDA	37	OPEN	2648228-49/12	U	-	
4	047B10D075	BDA	21	OPEN	2648228-19/7	D	-	
5	047B10D132	BDA	22	GND	2648228-22/7	D	-	
6	047B10D153	BDA	23	OPEN	2648228-21/7	D	-	
7	047B10D156	BDA	4	OPEN	2648228-21/1	D	-	
8	047B10D156	BDA	7	OPEN	2648228-21/8	D	-	
9	047B10D156	BDA	35	GND	2648228-21/11	D	-	
10	047B10E102	BDA	16	OPEN	2648228-42/5	U	-	
11	047B10E069	BDA	27	OPEN	2648228-19/9	D	-	
12	047B10D084	BDB	33	OPEN	2648228-19/7	D	-	
13	047B10D048	BDC	27	OPEN	2648228-40/3	U	-	
14	047B10D048	BDC	38	OPEN	2648228-40/3	U	-	
15	047B15C129	ADH	20	OPEN	2648228-15/2	D	-	
16	047B15D111	ADH	12	OPEN	2648228-16/4	D	-	
17	047B15C042	BDA	2	OPEN	2648228-10/1	D	-	
18	047B15C114	BDA	15	OPEN	2648228-15/4	D	-	
19	047B15E060	BDA	24	OPEN	2648228-08/8	D	-	
20	047B15E093	BDA	38	OPEN	2648228-47/12	U	-	
21	047B15G042	BDA	20	OPEN	2648228-30/6	D	-	
22	047B15G084	BDA	3	OPEN	2648228-07/1	D	-	
23	047B15B066	BDB	27	OPEN	2648228-26/7	D	-	
24	047B15D063	BDB	27	GND	2648228-07/6	D	-	
25	047B15E078	BDB	6	GND	2648228-47/3	U	-	
26	047B15F051	BDC	4	OPEN	2648228-08/2	D	-	
27	047B15F051	BDC	22	OPEN	2648228-48/4	U	-	
28	047B15D120	BDH	37	OPEN	2648228-16/8	D	-	
29	047B15E048	BDH	5	OPEN	2648228-07/2	U	-	
30	047B15E063	CDD	5	OPEN	2648228-04/1	D	-	

Table A-4. Fault List for Multiplexer Controller

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	440D02B099	AHD	21	O/SA1	7	D	A14704-1	
2	440D02B144	AHD	37	O/SA0	9	D	INS	
3	440D02A093	BBB	25	I/SA0	70	D	INS	
4	440D02E027	BBB	17	O/SA0	87	U	INS	
5	440D02F141	BDL	7	I/SA0	21	D	INS	
6	440D02F144	BDL	18	I/SA0	21	D	INS	
7	440D02G057	BDL	22	I/SA1	33	D	INS	
8	440D02G114	BDL	14	O/SA0	24	D	INS	
9	440D02A147	CBF	11	O/SA0	7	D	INS	
10	440D02D087	CBF	5	O/SA0	84	D	INS	
11	440D02F102	CBF	26	I/SA0	81	D	G09609-0	
12	440D02F123	CBF	12	I/SA1	47	D	31-1	
13	440D02E174	FDA	23	I/SA0	38	D	INS	
14	440D02A051	GBB	38	O/SA0	55	D	INS	
15	440D02B081	GYB	23	O/SA0	42	D	INS	
16	440D02B111	GYB	40	O/SA1	42	D	INS	
17	440D02F075	GYB	21	I/SA0	48	D	INS	
18	440D02G081	GYB	30	O/SA1	51	D	INS	
19	440D02G081	GYB	34	I/SA0	51	D	INS	
20	440D02G087	GYB	33	O/SA1	51	D	INS	
21	440D02E135	LDC	4	O/SA0	34	D	INS	
22	440D02B054	LDN	9	O/SA1	18	D	INS	
23	440D02A039	LDQ	12	O/SA1	59	D	B06340-0	
24	440D02A039	LDQ	21	O/SA1	59	D	B05438-1	
25	440D02D099	LDQ	4	O/SA1	5	D	INS	
26	440D02C069	LHH	12	O/SA0	18	D	INS	
27	440D02F120	PDL	31	O/SA1	34	D	D12603-1	
28	440D02F159	PDL	15	I/SA1	1	D	INS	
29	440D02E138	RBF	17	O/SA0	33	D	INS	
30	440D02G030	RBG	25	O/SA0	35	D	INS	

Table A-5. Fault List for Computer Interface Unit

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	440D15B096	EQD	17	O/SA0	13	D	INS	
2	440D15D084	EQG	20	O/SA1	39	D	B13240-1	
3	440D15D087	EQG	20	O/SA1	20	D	INS	
4	440D15D087	EQG	30	I/SA1	20	D	INS	
5	440D15A066	KDN	15	O/SA1	50	U	B09039-1	
6	440D15C027	KDN	16	I/SA1	4	D	INS	(Failed MDF test)
7	440D15D147	KDR	25	O/SA1	27	U	C126B-0	
8	440D15D147	KDR	22	I/SA0	27	D	INS	
9	440D15C126	LHN	27	I/SA0	27	D	D14723-1	
10	440D15C042	PDL	13	O/SA1	6	D	INS	
11	440D15A132	RBF	13	O/SA0	29	D	INS	
12	440D15D111	RBF	28	I/SA0	35	D	B11109-1	
13	440D09A045	AGD	24	I/SA1	71	D	INS	(Tape)
14	440D09F108	AGD	39	I/SA1	58	D	INS	
15	440D09D042	BBB	20	I/SA0	28	D	INS	
16	440D09A069	BDL	14	O/SA0	69	D	A03908-0	(Tape failed MXC)
17	440D09A087	BDL	21	O/SA1	73	D	A04538-1	(Tape)
18	440D09A102	BDL	6	I/SA1	70	U	INS	
19	440D09A126	BDL	15	O/SA0	80	D	A06326-0	
20	440D09B051	BDL	21	O/SA0	72	D	A04532-0	
21	440D09B087	BDL	7	I/SA1	75	D	INS	(Tape)
22	440D09B138	BDL	17	I/SA1	85	D	INS	
23	440D09D078	EQJ	34	I/SA0	47	D	INS	
24	440D09E048	FDA	8	O/SA1	94	U	INS	
25	440D09E114	JDB	33	O/SA1	96	D	INS	
26	440D09C027	KDN	27	O/SA0	28	U	INS	
27	440D09E024	KDN	17	O/SA1	58	U	INS	
28	440D09E153	LDQ	26	O/SA0	95	D	INS	
29	440D09B039	PDL	3	I/SA1	18	U	A04206-1	
30	440D09D159	RBF	37	O/SA0	35	D	C15330-0	

Table A-6. Fault List for Keyboard Subsystem

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	441B05B102	BDL	21	O/SA0	10	D	B06331-0	
2	441B05B093	DQD	31	O/SA1	5	D	INS	
3	441B05B057	EQG	13	I/SA1	5	D	INS	
4	441B05B042	FDA	21	O/SA1	14	D	INS	
5	441B05B072	FDA	26	O/SA0	16	D	INS	
6	441B05B072	FDA	34	I/SA1	16	D	INS	
7	441B05B090	FDA	11	I/SA0	17	D	INS	
8	441B05A144	KDN	31	I/SA1	18	D	INS	
9	441B05A150	KDN	36	I/SA1	20	U	INS	
10	441B05A150	KDN	12	I/SA1	20	U	INS	
11	441B05A153	KDN	11	O/SA1	20	D	A13519-1	
12	441B05A153	KDN	19	O/SA0	20	D	A12929-0	
13	441B05A153	KDN	18	I/SA1	20	D	INS	
14	441B05A084	KDR	9	O/SA0	7	D	INS	
15	441B05A084	KDR	12	O/SA1	7	D	INS	
16	441B05A147	LDC	30	O/SA1	19	U	INS	
17	441B05B081	LDC	29	O/SA0	9	D	INS	
18	441B05B114	LDC	15	O/SA1	5	D	INS	
19	441B05A081	LDN	26	O/SA1	9	D	INS	
20	441B05A081	LDN	35	O/SA0	9	D	INS	
21	441B05A057	LDP	4	O/SA1	17	D	A06331-1	
22	441B05A054	LDQ	16	O/SA0	14	D	INS	
23	441B05A054	LDQ	4	O/SA1	14	D	INS	
24	441B05A069	LDQ	8	I/SA1	15	D	INS	
25	441B05A069	LDQ	29	O/SA0	15	D	INS	
26	441B05A075	LDQ	14	I/SA1	17	D	INS	
27	441B05A123	LDQ	39	O/SA0	19	D	A14729-1	
28	441B05B096	LDQ	34	I/SA1	17	U	INS	
29	441B05B132	MHK	17	O/SA1	4	D	A11718-1	
30	441B05A105	MKL	26	I/SA0	23	D	INS	

Table A-7. Fault List for Printer Subsystem

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	456D14A060	BDL	15	O/SA1	12	D	B06038-1	
2	456D14A036	DQD	7	I/SA0	5	U	INS	
3	456D14A057	DQD	37	O/SA1	7	D	A12908-1	
4	456D14A066	EQG	32	I/SA1	7	D	INS	
5	456D14A033	EQJ	28	I/SA1	6	D	INS	
6	456D14A084	FDA	39	O/SA1	10	D	INS	
7	456D14A069	KDR	25	O/SA1	26	D	INS	
8	345D14A078	KDR	32	O/SA1	25	D	INS	
9	456D14A078	KDR	37	I/SA0	25	D	INS	
10	456D14A078	KDR	23	I/SA0	25	D	INS	
11	456D14A078	KDR	17	O/SA0	25	D	INS	
12	456D14A126	KDR	34	I/SA0	26	D	INS	
13	456D14B120	KDR	29	O/SA0	22	D	INS	
14	456D14B120	KDR	24	I/SA0	22	D	INS	
15	456D14A105	LDC	35	I/SA1	11	D	A12314-1	
16	456D14B123	LDC	9	I/SA0	13	U (U)	B12902-1	
17	456D14B123	LDC	21	O/SA1	13	D	B12027-1	
18	456D14B114	LDN	38	I/SA0	19	D	B13809-0	
19	456D14B087	LDP	35	O/SA1	20	D	INS	
20	456D14A120	LDQ	37	I/SA1	9	D	INS	
21	456D14A120	LDQ	40	O/SA0	8	D (MAN)	A12328-0	
22	456D14B057	LDQ	9	I/SA1	16	D	INS	
23	456D14B060	LDQ	29	O/SA0	13	D	B09008-0	
24	456D14B060	LDQ	26	O/SA1	13	D	B09014-1	
25	456D14B105	LDQ	32	I/SA1	17	D	INS	
26	456D14B122	LDQ	4	O/SA0	20	D	A09018-1	
27	456D14A051	MMK	16	I/SA0	6	D	INS	
28	456D14A051	MMK	27	I/SA1	6	D	INS	
29	456D14B063	PDL	36	I/SA1	18	U	INS	
30	456D14B063	PDL	3	I/SA1	18	D	INS	

Table A-8. Fault List for Magnetic Tape File Subsystem

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	440C08C126	AGD	9	O/SA0	41	D	INS	
2	440C08A033	BDL	27	I/SA1	13	D	INS	
3	440C08A069	BDL	14	O/SA1	13	D	30-1	
4	440C08B024	BDL	21	O/SA0	28	D	C05404-0	
5	440C08B036	BDL	28	I/SA1	27	D	INS	
6	440C08C081	DQD	20	O/SA0	44	D	C06335-0	
7	440C08B060	EQF	12	O/SA0	43	D	INS	
8	440C08A054	FDA	39	O/SA0	26	D	23-0	
9	440C08B084	FDA	8	O/SA1	20	D	INS	
10	440C08B090	FDA	23	I/SA0	22	D	INS	
11	440C08C030	FDA	33	I/SA0	25	D	INS	
12	440C08B135	FQB	6	I/SA0	46	U	INS	
13	440C08A099	GYB	40	O/SA1	10	D	INS	
14	440C08A111	KDJ	25	I/SA1	17	D	INS	
15	440C08C150	KDN	38	O/SA0	40	D	C12629-0	
16	440C08C150	KDN	19	O/SA1	40	D	C12613-1	
17	440C08A090	KDQ	14	I/SA0	16	D	INS	
18	440C08A090	KDQ	35	O/SA1	18	D	INS	
19	440C08A120	KDQ	18	O/SA1	47	D	A12906-1	
20	440C08B126	KDQ	5	O/SA1	37	D	B12908-1	
21	440C08B108	KDR	3	I/SA0	22	D	INS	
22	440C08B111	KDR	8	I/SA1	17	D	INS	
23	440C08A021	LDC	5	O/SA1	11	D	A01528-1	
24	440C08B096	LDC	40	O/SA1	47	D	INS	
25	440C08B102	LDC	13	I/SA1	38	See Log	330	
26	440C08C093	LDC	37	I/SA1	23	D	18-0	
27	440C08B087	LDN	39	O/SA0	13	D	INS	
28	440C08A060	LDQ	24	I/SA1	9	D	INS	
29	440C08A093	LDQ	6	I/SA0	9	U	B14108-0	
30	440C08C045	PDL	16	I/SA1	14	D	C02114-1	

Table A-9. Fault List for Test Control and Display Subsystem

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS**	AFI CROSS REFERENCE	COMMENTS
1	405-7-1-1D135	AGD	25	*I/SA0	67	D-1	INS	
2	405-7-1-1A051	BBB	22	I/SA1	69	D-1	C-0	
3	405-7-1-1B039	DBE	3	*I/SA0	33	D-1	B08136-1	
4	405-7-1-1B126	DBE	14	O/SA0	30	U	C09622-0	
5	405-7-1-1B132	DBE	23	O/SA0	29	D-1	A06921-1	
6	405-7-1-1B132	DBE	39	*I/SA0	29	D-1	B08106-1	
7	405-7-1-1B147	DBE	17	*I/SA0	36	U	B11116-1	
8	405-7-1-1C048	DBE	24	O/SA1	58	D-1	C11127-1	
9	405-7-1-1C075	DBE	32	*I/SA0	4	D-3	12-1	
10	405-7-1-1D018	DBE	28	I/SA1	22	D-1	30-0	
11	405-7-1-1D024	DBE	4	*O/SA0	18	D-1	INS	
12	405-7-1-1D027	DBE	12	O/SA0	24	D-2	INS	
13	405-7-1-1B075	DBF	5	*I/SA0	65	D-1	06-1	
14	405-7-1-1B093	DBF	34	*I/SA0	45	D-1	A09027-1	
15	405-7-1-1B105	DBF	19	*I/SA0	28	D-2	B09006-0	
16	405-7-1-1C108	DBF	9	*I/SA0	63	U	29-1	
17	405-7-1-1A090	DBG	7	*I/SA0	45	D-1	04-1	
18	405-7-1-1D063	DBG	40	I/SA1	4	U	INS	
19	405-7-1-1D063	DBG	2	*I/SA0	4	D-2	B054C-0	
20	405-7-1-1B030	DBH	4	O/SA0	33	U	D07218-1	
21	405-7-1-1D099	DBH	15	I/SA1	39	D-1	INS	
22	405-7-1-1D156	DBH	25	*I/SA0	60	D-1	04-1	
23	405-7-1-1B048	EBH	37	O/SA1	8	D-3	INS	
24	405-7-1-1B057	EBH	30	O/SA0	7	D-3	INS	
25	405-7-1-1C024	EBH	28	*O/SA0	6	D-3	INS	
26	405-7-1-1C135	EBH	34	O/SA1	13	D-3	INS	
27	405-7-1-1C138	EBH	40	O/SA0	15	D-4	INS	
28	405-7-1-1D138	EQG	21	I/SA1	66	U	INS	
29	405-7-1-1D042	KBR	32	O/SA0	19	D-2	D11405-0	
30	405-7-1-1D081	ZBY	24	O/SA0	1	D-1	INS	

* System Extender Used

**ITOP AUTO - 1
KBD AUTO - 2
ITOP MAN - 3
KBD MAN - 4

Table A-10. Fault List for Digital Read-In Subsystem

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	45B-A090	BBB	18	O/SA0	8	D	INS	
2	45B-E099	BDL	14	O/SA1	61	D	F08416-1	
3	45B-C117	EQF	36	I/SA1	12	D	INS	
4	45B-A048	FDA	3	I/SA0	8	D	INS	
5	45B-A066	FDA	23	I/SA0	6	D	INS	
6	45B-B099	GBB	11	O/SA1	27	D	A09640-1	
7	45B-B117	GBB	35	O/SA0	53	D	A11406-0	
8	45B-E144	GBB	15	I/SA0	46	D	INS	
9	45B-E150	GBB	30	I/SA1	49	D	INS	
10	45B-D114	GDN	37	I/SA1	20	D	INS	
11	45B-A039	HVA	2	I/SA0	8	U	-	
12	45B-A057	KDR	9	O/SA0	7	U	E-0	
13	45B-A057	KDR	8	I/SA1	7	D	INS	
14	45B-A078	KDR	25	O/SA1	9	D	C11422-1	
15	45B-A099	KDR	2	O/SA0	11	D	INS	
16	45B-B111	KDR	13	I/SA1	64	D	13-0	
17	45B-D102	KDR	6	I/SA1	66	D	INS	
18	45B-D102	KDR	23	I/SA1	66	D	INS	
19	45B-E102	KDR	40	O/SA1	39	U	F07234-1	
20	45B-F045	LDC	29	O/SA0	38	D	12-0	
21	45B-B150	LDC	29	O/SA0	18	D	INS	
22	45B-B147	LDN	9	O/SA1	64	D	A13809-0	
23	45B-A051	LDQ	22	I/SA1	27	D	INS	
24	45B-A054	LDQ	7	I/SA0	6	U	A05727-1	
25	45B-A054	LDQ	24	I/SA0	6	D	AC4215-0	
26	45B-C099	LDQ	4	O/SA1	29	D	C10827-0	
27	45B-C123	LDQ	26	O/SA1	33	U	D12630-1	
28	45B-C147	LDQ	21	O/SA1	68	D	INS	
29	45B-F135	LDQ	3	O/SA0	52	D	26-1	
30	45B-F135	LDQ	35	O/SA0	52	D	INS	

Table A-11. Fault List for Hardware Alarm Detection Logic

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	451D14A111	BBB	15	I/SA0	21	D	F-0	
2	451D14A099	BDL	25	I/SA0	8	U	INS	
3	451D14A099	BDL	21	O/SA1	8	D	B07812-1	
4	451D14A105	BDL	14	O/SA1	7	D	B07812-1	
5	451D14C102	BDL	8	I/SA1	6	U	INS	
6	451D14C102	BDL	37	I/SA0	6	D	INS	
7	451D14C105	BDL	21	O/SA0	6	D	C07539-1	
8	451D14A090	DQD	5	O/SA1	17	D	INS	
9	451D14C084	FDA	19	I/SA1	3	D	INS	
10	451D14C084	FDA	26	O/SA1	3	D	INS	
11	451D14C096	GDN	40	I/SA1	5	-	INS	*Could not extend
12	451D14A126	KDN	2	I/SA1	21	U	INS	
13	451D14A129	KDN	12	I/SA0	22	U	INS	
14	451D14A054	KDP	9	O/SA0	13	D	16-0	
15	451D14A054	KDP	7	I/SA1	13	D	INS	
16	451D14A057	KDP	17	I/SA0	12	D	INS	
17	451D14A066	KDP	22	I/SA1	14	D	12-0	
18	451D14A075	KDP	8	I/SA0	10	D	INS	
19	451D14B066	KDR	11	O/SA0	15	D	INS	
20	451D14B087	KDR	37	I/SA1	19	D	INS	
21	451D14B069	LDC	18	O/SA0	9	D	INS	
22	451D14B069	LDC	14	O/SA1	9	U	INS	
23	451D14B069	LDC	3	I/SA0	9	D	B07535-0	
24	451D14B069	LDC	38	O/SA0	9	D	INS	
25	451D14C081	LDC	3	I/SA1	23	U	C10229-0	
26	451D14C081	LDC	36	O/SA1	23	D	INS	
27	451D14B078	LDN	13	I/SA0	15	D	12-1	
28	451D14C069	LDQ	28	O/SA0	3	D	INS	
29	451D14C078	LDQ	24	I/SA0	3	D	03-1	
30	451D14C078	LDQ	3	O/SA0	3	D	INS	

Table A-12. Fault List for Time-of-Day Controller

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	456D09B039	BDM	9	O/SA0	2	U	INS	DCG EQUIP & DCSS - Red
2	456D09B039	BDM	8	O/SA1	2	U	B06639-1	
3	456D09A048	BDN	24	O/SA1	8	D	INS	
4	456D09A054	BDN	13	O/SA0	6	D	INS	
5	456D09A072	BDN	27	O/SA0	4	D	A05415-0	
6	456D09B063	BDN	17	O/SA1	9	D	INS	
7	456D09A075	JBK	8	O/SA1	9	D	INS	
8	456D09B084	JBK	7	O/SA0	9	U	36-0	
9	456D09B054	KBR	15	I/SA0	13	U	INS	
10	456D09A039	LDC	25	I/SA1	12	U	04-0	
11	456D09A039	LDC	2	I/SA1	1	D	21-0	
12	456D06B093	BDN	4	I/SA1	18	D	INS	
13	456D06A084	DBE	29	I/SA1	12	D	INS	
14	456D06A084	DBE	16	O/SA1	13	D	INS	
15	456D06A039	DBF	35	O/SA1	8	D	INS	
16	456D06A078	DBF	22	I/SA1	11	D	INS	
17	456D06C051	DBG	34	I/SA0	5	D	C07224-1	
18	456D06C060	DBG	39	O/SA1	4	D	INS	
19	456D06A066	DBH	4	O/SA1	10	U	A05433-0	
20	456D06A111	EBH	11	I/SA1	22	D	INS	
21	456D06A114	EBH	30	O/SA0	22	D	INS	
22	456D06B102	EBH	33	O/SA0	16	D	A13239-0	
23	456D06B102	EBH	23	O/SA1	16	D	A12934-1	
24	456D06A102	EQF	21	I/SA0	12	D	INS	
25	456D06B084	KBR	4	O/SA1	19	U	INS	
26	456D06A099	LDC	30	O/SA1	20	D	INS	
27	456D06B078	ZBY	31	O/SA0	19	U	17-0	
28	456D06C048	ZBY	16	I/SA1	4	D	INS	
29	456D06C054	ZBY	14	O/SA0	3	D	INS	
30	456D06C057	ZBY	12	I/SA1	2	D	INS	

Table A-13. Fault List for Data Converter Subsystem

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	456C1XA114	DQD	19	I/SA1	16	D	INS	
2	456C1XA114	DQD	40	I/SA0	16	D	INS	
3	456C1XA111	EQF	5	O/SA0	15	D	A10234-0	
4	456C1XB090	EQG	16	I/SA1	16	D	INS	
5	456C1XA093	FDA	34	I/SA1	15	D	INS	
6	456C1XA093	FDA	36	O/SA0	15	D	INS	
7	456C1XA129	FDA	16	I/SA0	15	D	A13209-0	
8	456C1XA129	FDA	21	O/SA1	15	D	INS	
9	456C1XA129	FDA	33	I/SA0	15	D	INS	
10	456C1XA129	FDA	35	O/SA0	15	D	INS	
11	456C1XA129	FDA	17	I/SA0	15	D	INS	
12	456C1XA135	FDA	14	O/SA0	15	D	A12608-1	
13	456C1XA150	FDA	38	O/SA1	16	D	INS	
14	456C1XA150	FDA	36	O/SA0	16	D	A11418-0	
15	456C1XA150	FDA	17	I/SA0	16	D	INS	
16	456C1XB093	GDN	2	O/SA0	15	D	INS	
17	456C1XB093	GDN	7	O/SA0	15	D	INS	
18	456C1XB096	GDN	37	I/SA0	15	D	INS	
19	456C1XA147	HVA	36	O/SA0	16	D	INS	
20	456C1XA153	KDN	9	I/SA0	15	D	INS	
21	456C1XA087	KDR	32	O/SA1	16	D	INS	
22	456C1XA087	KDR	8	I/SA0	16	D	INS	
23	456C1XA105	KDR	9	O/SA0	15	D	14-0	
24	456C1XA108	KDR	2	O/SA1	16	D	INS	
25	456C1XA108	KDR	14	I/SA1	16	D	INS	
26	456C1XA126	KDR	12	O/SA0	15	D	INS	
27	456C1XA141	LDP	23	I/SA1	15	D	INS	
28	456C1XA141	LDP	4	O/SA1	15	D	A12608-1	
29	456C1XA099	LDQ	25	I/SA0	15	D	A10505-0	
30	456C1XA099	LDQ	22	I/SA1	15	D	INS	

Table A-14. Fault List for System Control Logic

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	450CXXC096	AGD	8	I/SA1	27	D	INS	
2	450CXXC096	AGD	17	I/SA1	27	D	INS	
3	450CXXC024	BBB	12	O/SA1	13	D	INS	
4	450CXXC027	BBB	40	I/SA0	12	D	INS	
5	450CXXB099	FDA	14	O/SA0	49	D	INS	
6	450CXXB108	FDA	28	I/SA0	48	U	INS	
7	450CXXC066	FDA	18	I/SA1	34	D	INS	
8	450CXXC075	FDA	33	I/SA1	45	U	INS	
9	450CXXC087	FDA	27	I/SA1	31	U	INS	
10	450CXXC093	FDA	22	O/SA1	30	D	C07840-0	
11	450CXXD132	FQB	5	O/SA1	30	D	INS	
12	450CXXA045	GDN	18	O/SA1	37	U	INS	
13	450CXXA048	GDN	9	O/SA1	39	U	INS	
14	450CXXB033	GDN	37	I/SA1	40	U	INS	
15	450CXXA141	KDN	25	I/SA0	4	D	INS	
16	450CXXA147	KDN	14	I/SA0	51	U	INS	
17	450CXXB075	KDR	5	I/SA1	35	U	INS	
18	450CXXB075	KDR	24	I/SA1	35	U	INS	
19	450CXXB120	KDR	6	I/SA0	18	D	INS	
20	450CXXB120	KDR	19	O/SA0	18	U	E-0	
21	450CXXA093	LDC	34	I/SA0	6	D	B10802-1	
22	450CXXA093	LDC	22	I/SA1	6	D	B10803-0	
23	450CXXA111	LDC	22	I/SA0	51	U	C06612-0	
24	450CXXB111	LDN	24	I/SA0	6	U	B114B-0	
25	450CXXC072	LDN	12	O/SA1	15	U	INS	
26	450CXXB105	LDP	22	I/SA0	46	U	B06322-1	
27	450CXXB090	LDQ	35	O/SA0	18	D	B12014-0	
28	450CXXB096	LDQ	32	I/SA0	10	D	12-1	
29	450CXXC048	LDQ	21	O/SA1	6	D	INS	
30	450CXXB048	MHK	14	I/SA0	36	D	INS	

Table A-15. Fault List for System Mode Configuration Logic

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	451DXXB057	BBB	6	O/SA0	12	U	INS	
2	451DXXD042	FDA	18	I/SA1	85	D	INS	
3	451DXXA132	KDR	9	O/SA0	43	U	INS	
4	451DXXA132	KDR	24	I/SA1	43	D	INS	
5	451DXXD096	KDR	3	I/SA0	45	U	INS	
6	451DXXA057	LDC	23	O/SA1	49	U	INS	DCG-1 column/multi-color
7	451DXXA117	LDC	16	O/SA0	3	U	INS	
8	451DXXA126	LDC	36	O/SA0	41	U	INS	
9	451DXXB045	LDC	21	O/SA0	24	U	C05134-1	
10	451DXXB087	LDC	22	I/SA0	10	U	A08708-1	
11	451DXXD087	LDC	15	O/SA1	47	U	INS	Indications overall/multi-color
12	451DXXD126	LDC	2	I/SA0	20	U	D11731-1	DCG-1 column/multi-color
13	451DXXE117	LDC	7	I/SA0	8	U	08-1	
14	451DXXA081	LDN	34	I/SA1	8	U	INS	
15	451DXXA099	LDN	26	O/SA0	6	U	A06335-0	
16	451DXXA108	LDN	31	I/SA1	6	U	INS	
17	451DXXA120	LDN	12	O/SA1	43	U	A10226-1	
18	451DXXB078	LDN	40	I/SA0	60	D	39-1	
19	451DXXB063	LDP	21	I/SA1	38	U	INS	
20	451DXXB090	LDP	19	I/SA1	38	U	INS	
21	451DXXA084	LDQ	35	O/SA0	7	U	A07235-0	Primary mode column/multi-color
22	451DXXA087	LDQ	13	O/SA0	10	U	INS	
23	451DXXB096	LDQ	39	O/SA1	12	U	INS	
24	451DXXC048	LDQ	27	I/SA0	24	U	C03928-0	
25	451DXXE054	LDQ	4	O/SA0	68	D	E09014-1	
26	451DXXE072	LDQ	16	O/SA1	60	D	E11140-0	
27	451DXXE087	LDQ	5	I/SA0	66	U	02-1	Unable to run test
28	451DXXA021	PDL	13	I/SA0	56	U	INS	DRISS #5/multi-color
29	451DXXE111	PDL	22	O/SA1	79	D	INS	
30	451DXXE138	PDL	9	O/SA1	78	D	B13528-1	

Table A-16. Fault List for Computer Maintenance Subsystem

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	440B12A069	BBB	2	O/SA0	10	D	INS	
2	440B12B063	FDA	40	I/SA1	78	D	INS	
3	440B12A066	GBB	7	I/SA0	10	D	INS	
4	440B12A111	KDR	25	O/SA0	9	U	INS	
5	440B12A081	LDC	36	O/SA0	10	D	INS	
6	440B05C024	BBB	37	O/SA0	43	U	INS	
7	440B05C036	BBB	30	O/SA0	40	U	INS	
8	440B05D069	BDL	21	O/SA0	75	D	C07205-1	
9	440B05E087	GBB	3	I/SA1	69	U	INS	
10	440B05G063	GBB	29	O/SA1	70	D	G13230-0	
11	440B05F057	KDQ	15	I/SA1	67	D	INS	
12	440B05F072	KDQ	13	O/SA0	93	D	INS	
13	440B05A093	KDR	31	I/SA1	42	U	INS	
14	440B05B084	KDR	24	I/SA1	33	D	INS	
15	440B05B126	LDC	9	I/SA1	76	D	D12937-0	
16	440B05C144	LDC	28	I/SA0	52	D	B15933-1	
17	440B05D138	LDC	17	I/SA0	53	U	C13827-1	
18	440B05D156	LDC	8	O/SA1	54	U	B14735-0	
19	440B05G078	LDC	17	I/SA0	31	D	15-0	
20	440B05G144	LDN	21	O/SA1	5	D	INS	
21	440B05A144	LDQ	15	I/SA1	53	U	INS	
22	440B05B051	LDQ	29	O/SA1	73	D	INS	
23	440B05B096	LDQ	23	I/SA1	73	D	INS	
24	440B05B096	LDQ	29	O/SA1	73	U	E06905-0	
25	440B05D021	LDQ	22	I/SA0	66	U	F021A-0	
26	440B05D021	LDQ	28	O/SA0	66	D	E05408-1	
27	440B05C057	MML	14	I/SA0	62	D	INS	
28	440B05D054	PDL	27	I/SA0	62	U	E030B-0	
29	440B05E138	PDL	11	I/SA0	15	D	INS	
30	440B05F078	PDL	25	O/SA1	17	D	E09336-1	

Table A-17. Fault List for Fire Control Clock Oscillator

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	456C0XA105	BBB	14	I/SA0	9	U	-	
2	456C0XA105	BBB	29	I/SA1	9	U	-	
3	456C0XA105	BBB	33	O/SA1	9	U	-	
4	456C0XA108	BBB	26	I/SA0	10	U	-	
5	456C0XA111	BBB	4	I/SA1	13	U	-	
6	456C0XA111	BBB	14	I/SA0	13	U	-	
7	456C0XA114	BBB	2	O/SA1	8	U	-	
8	456C0XA117	BBB	3	O/SA1	8	U	-	
9	456C0XA117	BBB	22	I/SA1	8	U	-	
10	456C0XA117	BBB	7	I/SA1	8	U	-	
11	456C0XA120	BBB	5	O/SA0	8	U	-	
12	456C0XA066	FDA	39	O/SA0	6	U*	-	Sys error 20400
13	456C0XA072	FDA	38	O/SA0	7	U*	-	Sys error 20400
14	456C0XA072	FDA	23	I/SA0	7	U	-	
15	456C0XA075	FDA	27	O/SA0	6	U*	-	Constant printout (see p.o.)
16	456C0XA075	FDA	15	O/SA0	6	U	-	
17	456C0XA081	FDA	34	I/SA1	6	U	-	
18	456C0XA069	HVA	4	O/SA0	4	U	-	
19	456C0XA063	KDN	3	O/SA1	5	U*	-	Sys error 20400
20	456C0XA084	KDR	24	I/SA0	5	U*	-	Sys error 20400
21	456C0XA090	KDR	8	I/SA1	4	U	-	
22	456C0XA090	KDR	2	O/SA0	4	U*	-	Sys error 20400
23	456C0XA096	LDC	21	O/SA0	5	U*	-	Sys error 20400
24	456C0XA087	LDQ	23	I/SA1	5	U	-	
25	456C0XA087	LDQ	4	O/SA0	5	U	-	
26	456C0XA087	LDQ	16	O/SA0	5	U*	-	Sys error 20400
27	456C0XA087	LDQ	6	I/SA1	5	U	-	
28	456C0XA099	LDQ	3	O/SA1	6	U	-	
29	456C0XA099	LDQ	21	O/SA1	6	U	-	
30	456C0XA093	MDL	2	O/SA0	14	U	-	

Table A-18. Fault List for Operator's Control Panel

FAULT NO.	MODULE LOCATION	KEY CODE	PIN NO.	FAULT TYPE	ALI/MAD SHEET	TEST RESULTS	AFI CROSS REFERENCE	COMMENTS
1	405-8-1-3C084	BDN	35	O/SA0	34	-	-	BYP column - #11 out
2	405-8-1-3A072	DBG	21	O/SA0	9	-	-	TCB output blinking
3	405-8-1-3A072	DBG	35	O/SA0	12	-	-	TCB output blinking
4	405-8-1-3A135	DBG	18	I/SA0	16	-	-	Prepare - 05 white the #1 superimposed
5	405-8-1-3A138	DBH	35	O/SA0	10	-	-	Inhibited next lamp/AWAY/HOLD column - constant white HOLD
6	405-8-1-3D135	DBH	40	O/SA0	33	-	-	Undetected
7	405-8-1-3B033	EBH	2	I/SA0	1	-	-	GI column - no indication for msl #1
8	405-8-1-3B042	EBH	31	I/SA0	4	-	-	BYP column - constant DCC spin-up yellow msl #4
9	405-8-1-3B108	EBH	36	O/SA1	5	-	-	OAG STA #6 superimposed by a constant STA #5
10	405-8-1-3B120	EBH	32	I/SA1	1	-	-	AWAY/HOLD column - msl #1 constantly OUT
11	405-8-1-3B126	EBH	39	O/SA1	17	-	-	STATUS INIT column - red NAV NOT READY msl #17
12	405-8-1-3B132	EBH	27	O/SA0	6	-	-	AWAY/HOLD column - msl #6 OUT
13	405-8-1-3C120	EBH	39	O/SA1	42	-	-	STATUS INIT column - constant green msl 1SQ msl #24
14	405-8-1-3C126	EBH	12	I/SA1	26	-	-	OAG-constant STA 11/AWAY/HOLD column - multidisplay msl #11
15	405-8-1-3C126	EBH	37	O/SA0	26	-	-	AWAY/HOLD column - no TMPS yellow msl #11
16	405-8-1-3C129	EBH	32	I/SA1	24	-	-	AWAY/HOLD column - no HOLD indication msl #9
17	405-8-1-3D063	EBH	29	O/SA1	29	-	-	STATUS INIT column - constant red NAV NOT READY msl #14
18	405-8-1-3D108	EBH	30	O/SA0	26	-	-	STATUS INIT column - no red LCHR NOT 1SQ msl #11
19	405-8-1-3A048	GDN	6	O/SA0	23	-	-	STATUS INIT column - multi-ind. msls #2 and #8/remainder OUT
20	405-8-1-3D090	GDN	5	O/SA1	44	-	-	Undetected
21	405-8-1-3D093	DBF	3	O/SA0	37	-	-	Denote 3 displays constant 0
22	405-8-1-3A063	KDR	25	O/SA0	9	-	-	Undetected
23	405-8-1-3D057	KDR	6	I/SA1	33	-	-	Undetected
24	405-7-1-2D069	DBH	40	O/SA0	15	-	-	Undetected
25	405-7-1-2D051	DBF	21	O/SA1	14	-	-	Undetected
26	405-7-1-2D057	DBF	22	I/SA0	17	-	-	Multicolored A/Is
27	405-7-1-2C033	EBH	27	O/SA0	21	-	-	DATA ENTRY - OUT
28	405-7-1-2C039	EBH	28	O/SA1	20	-	-	PRI MODE column - FC TEST WAIT green constantly
29	405-7-1-2C078	EBH	25	O/SA1	22	-	-	DRISS #4 displays constant L6
30	405-7-1-2C057	EBH	2	I/SA0	22	-	-	DCG XMSM red/NO SYS PRTR and L9 superimposed

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